

- Sub A1
- 1 1. An open loop method of controlling flow rate of a fluid through a
2 valve flow modulating member that is controlled by a position of a valve stem, the
3 method comprising:
4 setting a target flow rate;
5 determining a target valve stem position based on the target flow rate; and
6 adjusting the valve stem position until a position of the valve stem matches
7 the target valve stem position.
- 1 2. The method of claim 1, wherein determining the target valve stem
2 position comprises:
3 determining a pressure coefficient;
4 calculating a flow area of the valve flow modulating member; and
5 determining a valve stem position corresponding to the calculated flow area.
- 1 3. The method of claim 2, wherein calculating the flow area of the valve
2 flow modulating member comprises using the measured flow rate and the determined
3 pressure coefficient.
- 1 4. The method of claim 2, wherein determining the valve stem position
2 comprises using a predetermined relationship between the valve stem position and the
3 flow area.
- 1 5. The method of claim 2, wherein calculating the flow area of the valve
2 flow modulating member comprises modelling flow rate through the valve flow
3 modulating member to determine a relationship between a function of fluid pressure
4 upstream and downstream from the valve flow modulating member, the flow area of the
5 valve flow modulating member, and the flow rate through the valve flow modulating
6 member.
- 1 6. The method of claim 5, wherein the modelling assumes that an internal
2 energy of the fluid is constant across the valve flow modulating member.

1 7. The method of claim 5, wherein the modelling assumes that a density
2 of the fluid remains substantially constant across the valve flow modulating member.

1 8. The method of claim 2, wherein the fluid is in a gaseous state.

1 9. The method of claim 8, wherein calculating the flow area of the valve
2 flow modulating member comprises estimating a pressure of the fluid upstream from the
3 valve flow modulating member and a pressure of the fluid downstream from the valve
4 flow modulating member.

1 10. The method of claim 8, wherein the pressure coefficient includes a
2 squared pressure difference ratio.

1 11. The method of claim 8, wherein the pressure coefficient is estimated
2 using maximum and minimum flow conditions.

1 12. The method of claim 2, wherein the fluid is in a liquid state.

1 13. The method of claim 12, wherein the pressure coefficient is estimated
2 using maximum and minimum flow conditions.

1 14. The method of claim 12, wherein calculating the flow area of the valve
2 flow modulating member comprises estimating a pressure of fluid upstream from the
3 valve flow modulating member and a pressure of the fluid downstream from the valve
4 flow modulating member.

1 15. The method of claim 12, wherein the pressure coefficient includes a
2 ratio of the difference in the upstream pressure and the downstream pressure when the
3 valve flow modulating member is fully open to the difference in the upstream pressure
4 and the downstream pressure when the valve flow modulating member is fully closed.

1 16. A valve positioner system that controls a flow rate of a fluid through a
2 valve flow modulating member that is controlled by a position of a valve stem, the
3 system comprising:
4 a valve positioner coupled to the valve stem and configured to measure a
5 position of the valve stem;
6 a feed-forward flow controller configured to:
7 receive the measured valve stem position from the valve positioner,
8 receive the target flow rate from the flow controller, and
9 calculate a target valve stem position based on the target flow rate;
10 wherein the valve positioner adjusts the valve stem position until a position of
11 the valve stem matches the target valve stem position.

1 17. The system of claim 16, wherein the feed-forward flow controller is
2 configured to determine a pressure coefficient that is based on one or more estimates of
3 the pressure of the fluid relative to the valve flow modulating member.

1 18. The system of claim 17, wherein the feed-forward flow controller is
2 configured to:
3 calculate a flow area of the valve flow modulating member that corresponds to
4 the measured valve stem position; and
5 calculate a flow rate based on the calculated flow area and the pressure
6 coefficient.

1 19. The system of claim 18, wherein the target valve stem position is
2 calculated based on the calculated flow area.

1 20. The system of claim 19, wherein calculating the target valve stem
2 position comprises using a predetermined relationship between valve stem position and a
3 flow area of the valve flow modulating member.

1 21. The system of claim 18, wherein calculating the flow area comprises
2 using a predetermined relationship between valve stem position and a flow area of the
3 valve flow modulating member.

1 22. The system of claim 18, wherein calculating the flow area of the valve
2 flow modulating member comprises modelling flow rate through the valve flow
3 modulating member to determine a relationship between a function of fluid pressure
4 upstream and downstream from the valve flow modulating member, the flow area of the
5 valve flow modulating member, and the flow rate through the valve flow modulating
6 member.

1 23. The system of claim 22, wherein the fluid is in a gaseous state.

1 24. The system of claim 23, wherein the modelling assumes that an
2 internal energy of the fluid is constant across the valve flow modulating member.

1 25. The system of claim 22, wherein the fluid is in a liquid state.

1 26. The system of claim 25, wherein the modelling assumes that a density
2 of the fluid remains substantially constant across the valve flow modulating member.

1 27. A valve positioner system that controls a flow rate of a fluid through a
2 valve flow modulating member that is controlled by a position of a valve stem, the
3 system comprising:

4 a valve positioner coupled to the valve stem and configured to measure a
5 position of the valve stem; and

6 a feed-forward flow controller configured to:

7 receive the measured valve stem position from the valve positioner,

8 receive the target flow rate from the flow controller,

9 receive a pressure coefficient,

10 calculate a first flow area based on the target flow rate and the pressure

11 coefficient;

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12 calculate a second flow area that corresponds to the measured valve
13 stem position,
14 calculate a flow rate based on the calculated second flow area and the
15 pressure coefficient,
16 calculate a target valve stem position based on the calculated first flow
17 area;
18 wherein the valve positioner adjusts the valve stem position until a position of
19 the valve stem matches the target valve stem position.